(a) "...we find criterion four... is, from a practical perspective, unworkable. ... Thus, criterion four does not appear to be necessary in order to implement the statutory definition of number portability." [18]

(b) "We clarify that by June 30, 1999, CMRS providers must (1) offer service provider portability in the 100 largest MSAs, and (2) be able to support nationwide roaming. Although we have not provided a specific phased development schedule for CMRS providers as we have for wireline carriers, we expect that CMRS providers will phase in implementation in selected switches over a number of months prior to the June 30, 1999, deadline for deployment." [19]

(c) "...CMRS carriers need only deploy local number portability by this deadline in the 100 largest MSAs in which they have received a specific request at least nine months before the deadline (i.e., a request has been received by September 30, 1998)." [20]

1.4.2   Wireless Industry Studies

During August, 1996, CTIA released a Notice of Request for Information (RFI) to the telecommunications industry. The goal of the RFI was to solicit potential methods available to the wireless industry for number portability implementation. CTIA received more than one hundred inquiries leading to several substantive responses.[21]   A Number Portability Forum was held October 9-11 in Las Vegas to review the presentations of the responses and find consensus on an approach to NP in the wireless industry.

On January 22, 1997, CTIA released to both TIA and Committee T1 standards committees a Standards Requirements Document (SRD) entitled *Wireless Number Portability CTIA Standards Requirement Document*. It provided the appropriate committees with an initial look into the requirements of WNP on current and future standards.

The FCC has sponsored a forum for agreeing to NP concepts via a Working Group under the North American Numbering Council (NANC). Since CMRS providers are regulated at the federal level (as opposed to the state level) and their participation in number portability is mandated, the involvement of WSPs and consideration of related wireless specific issues has become more crucial. This document is not intended to supersede any decisions made by these committees but is intended to capture portability as it involves WSPs.

---

[18] FCC *First Memorandum Opinion and Order on Reconsideration*, CC Docket 95-116, March 6, 1997, paragraph 19.

[19] ibid., paragraph 136.

[20] ibid., paragraph 137.

[21] Contact CTIA for more information.

1.5   Assumptions

The following assumptions are made throughout the WNP architecture:

- When a subscriber ports, the subscriber's current terminal equipment may or may not be compatible with the new SP's technology. A subscriber may need to purchase a new mobile station in order to obtain the services from a new WSP. Therefore, a subscriber may or may not port his or her mobile station.

- The NPAC-SMS will contain a record for each ported wireline DN and each ported MDN (within the area that it serves).

- Service providers are responsible for maintaining the integrity of their copy of the NPAC-SMS data.

- Each subscriber is identified by at least one unique NANP directory number that will port with the subscriber from one service provider to another.

- This document makes no assumptions regarding the number nor distribution of NPAC-SMSs, except that more than one will most likely be established and will be in place in time for WNP.

- Although this document most often refers to the number portability query database as residing on an NP-SCP, the WNP Solution does not preclude a WSP from locating the number portability query database on another platform such as an STP.

- This document details service provider portability for facility-based WSPs. It does not consider the complications of a re-seller environment in its discussions. (A facility-based WSP is one that operates at least one MSC.)

1.6   Aspects of Wireless Number Portability

Because wireless service providers have some fundamental differences in their network operation and services as compared to wireline, differences arise in the design and implementation of wireless number portability. These differences impact how and when subscribers can port to a wireless service provider. To appreciate these aspects, this section presents an overview of these differences, a logical discussion toward explaining wireless portability boundaries, as well as the definition of those boundaries.

1.6.1   Differences between Wireless and Wireline

The differences between wireline LECs and WSPs that impact the definition of portability are summarized in Table 1-1.

Table 1-1 Wireline versus Wireless Calling Aspects

Wireline	Wireless
A directory number is associated with a stationary physical facility (e.g. local loop).	A mobile directory number is not associated with any fixed physical loop.
The customer can only be served in a single static location with the same terminal.	The customer can be served over a wide geographic area with a single terminal. Mobility is inherent.
Aspects of local calling (including rating) are regulated by the states.	Aspects of local calling are not regulated by the states. Areas of local calling do not match those defined by wireline providers. Areas of local calling do not match from one WSP to another.
Incumbent LEC are bound by inter-LATA restrictions.	WSPs do not recognize the concept of LATAs.
Service Provider Portability is geographically bounded by rate centers.	Mobile-to-mobile and mobile outbound calls are not bounded by rate centers. Furthermore, wireline rate centers and similar wireless boundaries do not overlay one another.

The FCC definition of service provider portability does not distinguish between wireless or wireline service providers. However, since service provider portability should not disrupt current call rating, the inclusion of a WSP and the added complexities of the above differences must be carefully evaluated.

The definition of location portability infers that the number is associated with a physical, fixed facility. It involves changing rate centers associated with a number which presents significant impacts in rating the call of the originating party when the called party has moved their number to another rate center. However, the landline rate center definitions are not required to rate calls originated by wireless subscribers.

In light of these differences and in order to preserve the integrity of routing and rating of calls to wireless subscribers, whether ported or not, adjustments in interconnection and business agreements (e.g., Points of Interconnection (POI)) may be required.

1.6.2   Geographic Boundaries

1.6.2.1   Wireline Boundaries

In order to understand how wireless can participate in the FCC order without changing the wireline call rating, understanding call rating is fundamental. The concept of "rating" was created by wireline carriers as a method to capture distance related costs in billing. This concept

has been adopted by LECs for local calls as well as by IXCs for toll calls. Local carriers accomplished distance rating by defining a *rate center* as a geographic area associated with a single V(ertical) and H(orizontal) coordinate. Each telephone number by its NPA-NXX to an associated with a single rate center, often defined as the area served by a single switch (or a combination thereof). The distance related component of rating a call between two telephone numbers is, in essence, based on the difference of the two coordinates of their associated rate centers. Toll and long distance carriers adopted the same concept except that several rate centers may be aggregated to form a *rate district*. The rate district concept was then used to rate calls terminating outside of the local calling area (i.e., inter-city calls).

Today, wireline carriers associates wireless numbers (as defined by NPA-NXX) with a specific wireline rate center for mobile terminated calls. A wireline carrier can rate a wireline-to-wireless call based on the rate center V&H coordinates associated with calling and called party numbers.

A common assumption for service provider portability is that a subscriber originating a call should not be rated differently because of the called party's service provider or porting status. If a wireline subscriber originates a call, the rating should be the same regardless if the called party has ported to a WSP or where the serving MSC is located. Preserving the rating can be accomplished by WSPs having an interconnection agreements with the wireline SPs. Uniform treatment by wireline providers of calls to wireless subscribers continues to be an issue. Will the rating be based on the original wireline rate center or the fact that the subscriber is being served by a WSP? This issue remains for further study.

Rating calls to a portable wireless number is calculated using the rate center associated with the called party number (not the LRN). WNP does not define any requirement that a WSP obtain an LRN for every rate center associated with their serving area in order to accept a wireline subscriber desiring to port.

1.6.2.2 Wireless Boundaries

WSPs may rate calls originated by mobile subscribers; however, WSPs are not obligated to use the same physical boundaries of wireline rate centers or rate districts. Instead, WSPs utilize the concept of a geographical area referred to as a *Home Serving Area* (HSA). HSAs are typically much larger than the geography defined by a wireline rate center; for example:

- Basic Trading Area
- Metropolitan Service Area
- Major Trading Area

A WSP may define a portion of the above as a HSA or combine several of the above into a larger area. Unlike wireline rate centers which are regulated by the state utility commissions, HSAs are not subject to state jurisdiction (or any jurisdiction for that matter). Thus, the size of the HSA is a business decision of the WSP and frequently differs from one WSP to another.

Subscribers that originate calls within their HSA do not incur roaming charges. A WSP may define different "bands" or calling scopes within or across multiple HSAs which indicate that all mobile originated calls that terminate within the same "band" are rated the same.

1.6.2.3 Mobility versus Location Portability

Wireless users have the inherent ability to move while using their service; it is important to view this as *mobility*, not location portability. Being mobile does not impact the billing or rating for a wireline originated call. Mobility may impact the wireless subscriber through call forwarding charges and/or roaming fees.

Location Portability with respect to wireless is the ability to change Home Serving Areas or change the wireline rate center associated with the MDN. In this case, the wireline billing paradigm is impacted in the same way as with wireline location portability. For the wireless subscriber, this allows them to use their mobile set in a different area without incurring the roaming fees previously encountered .

1.6.3 Porting To and From

With wireline portability, any movement (i.e., relocation of the physical point of service) is technically considered location portability. However, it is recognized that the wireline implementation of service provider portability can "accommodate" a limited amount of location portability. That is, as long as the serving location is within the same rate center, the NP implementation does not impact billing or rating. Relocating outside the present rate center introduces significant billing and rating implications.

However, once a subscriber ports to a WSP, mobility is inherent. A subscriber can utilize the mobile station independent of any wireline rate center boundary. Furthermore, the subscriber can use the mobile station outside any HSA (subject to roaming agreements and charges). This mobility is transparent whether the subscriber chooses to actually relocate their residence or not.

1.6.3.1 Porting to a Wireless Service Provider

It is assumed that in order to be a recipient network, the WSP must have an FCC license to serve the location of the subscriber. The WSP is also assumed to provide radio coverage over the physical location where service was previously obtained by the ported subscriber. Serving the subscriber via a roaming agreement with another WSP does not constitute eligibility. Finally, WSPs are not required to have switching facilities within the same rate center area as the ported subscriber's DN NPA-NXX.

Given a WSP is eligible to receive a ported subscriber as defined in the above paragraph, the following criteria must be met to preserve the billing paradigm:

- A wireless subscriber can port the MDN to another WSP as long as the wireline rate center associated with the MDN is geographically located within the HSA of the involved WSPs.

- A wireless subscriber can port the MDN to a wireline SP as long as the resulting wireline SP is geographically located within the wireline rate center associated with the MDN's NPA-NXX.

- A wireline subscriber can port the DN to a WSP as long as the rate center associated with the wireline number is geographically located within the HSA of the involved WSP.

1.6.3.2 Porting to Wireline Service Provider

A subscriber that ports to a wireline carrier may have originally had their number assigned by a WSP. In this case, calls from other wireline subscribers should still be rated the same as before.

Each wireless number is associated with a rate center from a wireline perspective. The rate center may or may not be the same rate center where the wireless switch is located. Furthermore, the wireless subscriber may or may not reside in the rate center associated with their MDN. Consequently, to maintain consistent rating from the calling party's perspective, porting from a WSP to a wireline service provider can only occur when the resulting wireline service is geographically located within the wireline rate center associated with the ported MDN.

Abiding by such constraints does not impact wireline rating. Wireline calls rated on the called party number would continue to be rated the same. Assuming the subscriber has not moved, then from a rating perspective, the situation analogous to a subscriber using the mobile station at the subscriber's residence. Once the subscriber has ported to a wireline provider, that subscriber is constrained to using the telephone number only at a fixed location.

1.7   Critical Dates

1.7.1   Regulatory Mandates

Several dates are included in the FCC order concerning portability implementation. The earliest implementation of wireline service provider portability by the incumbent LECs in the top 100 Metropolitan Statistical Areas (MSAs) is 4Q97.

CMRS providers are not required to implement any technology to support wireline service provider portability by this date and thus, can continue to route calls to the donor LEC as normal. However, CMRS providers must make arrangements to complete calls to portable subscribers by December 31, 1998. Since calls made prior to this date will connect successfully nonetheless, this date is interpreted as requiring the WSP to either

- directly query a database and route the call to the proper network, or

- make business arrangements for another provider to query and properly route the call to the proper network.

The WSP need not own nor operate the database; the WSP may have a business relationship with another entity regarding access to that entity's database.

The second critical date involving CMRS providers is June 30, 1999. By this date, WSPs must be capable of receiving and releasing wireless ported subscribers and must have all the capabilities required for service provider portability.

1.7.2   Implementation

In order to consider the ability to comply with the FCC mandated dates, the aspect of standards and equipment availability must be considered. If one considers the normal development time of 2 years for standards, 18 months for equipment development beyond standards and 12 months for equipment deployment, the time line on the following page would apply.

Figure 1-1   Theoretical Timeline

In order to meet the end date, the intervals must shortened or overlapped. The following compressed timeline in Figure 1-2 is offered for consideration in planning for WNP.

Figure 1-2 Potential Timeline Necessary to Meet FCC Mandate

Note: that the time points above the line are either actual or derived by the FCC.

The following is a short description for each of the time points:

- *SRD to Standards*: This is a completed activity. The initial CTIA SRD on WNP was delivered to TIA, TR45.2, TR46 and T1P1 in January, 1997.

- *WNP Solutions Document*: This point represents the release of this document.

- *FCC Field Trial Report Available for Wireline*: This is the FCC ordered date for a report of the field trial of wireline

- *Industry Implementation Agreements and Standards Complete*: This is a derived date based on the time needed to develop and deploy equipment to meet the FCC dates. This substantially shortens the typical interval to develop standards and come to industry agreement.

- Bracketed area illustrates the time frame in which all of the following items much be accomplished in some form:

    - *Wireless Field Trial*: A field trial of the wireless solution must be made prior to deployment of equipment on any significant scale due to the fundamental impacts of these changes. Due to the limited time available, this trial must be on a limited scope and short time frame. Other forms of testing will also be necessary to prepare for and supplement the trial.
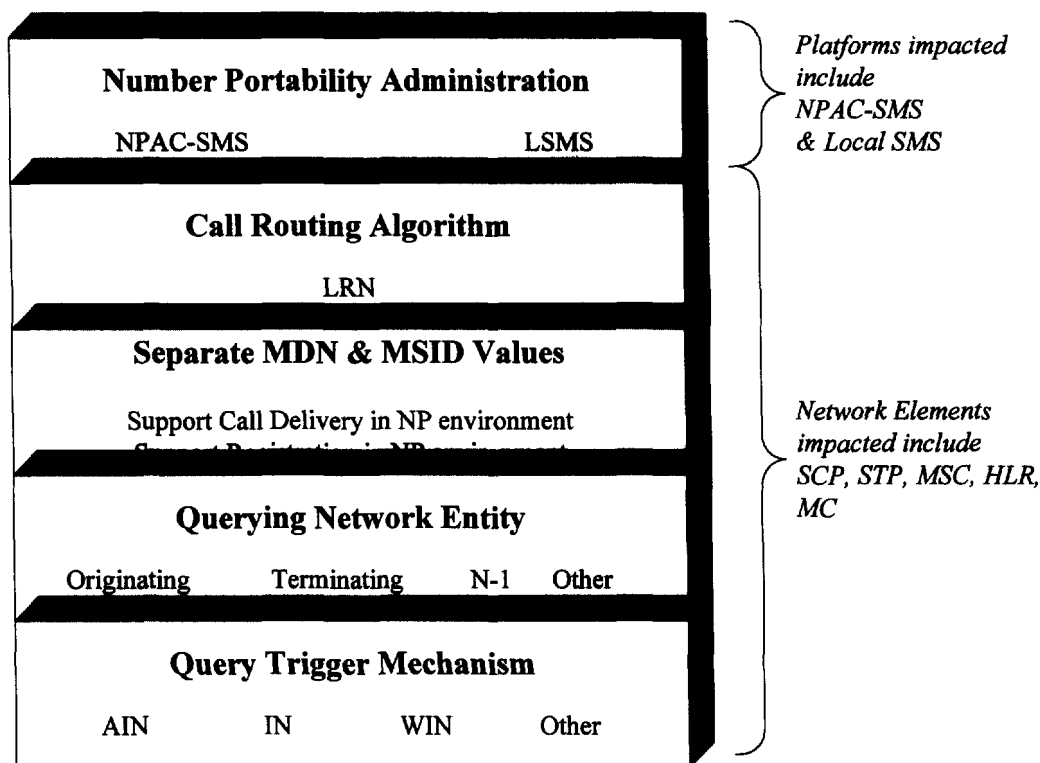
- *Initial Equipment Changes Available:* This date represents the initial availability of any equipment changes to meet the December 31, 1998, date for delivery of calls to ported wireline numbers. This is an evolutionary step to the final wireless solution, not a separate step.

- *Equipment Deployment*: This represents the time required to deploy the needed new equipment, software and changes throughout the industry - a significant task for the wireless industry as nationwide roaming requires all participating carriers to have this capability.

- *Final Equipment Changes Available*: After the initial testing of the equipment and software, a number of adjustments are normally expected. This milestone represents the point in time that the final changes would be available for deployment.

- *Equipment and Procedures Testing*: Even with a field trial, each carrier will need to test the deployment of equipment and procedures within their specific environment to ensure proper operation of maintenance customer care, billing procedures, et al.

• *Calls delivered to ported wireline numbers:* This is the FCC ordered date for wireless to be able to deliver calls to ported wireline numbers within the top 100 MSAs.

• *Top 100 MSA Number Portability Deployment Complete*: This represents the time in which all wireless carriers involved in roaming have deployed the necessary equipment and software to support number portability.

• *Full Nationwide Roaming of Wireless Ported Numbers*: This represents the time in which all needed equipment is deployed and roaming involving ported numbers can be activated. All necessary coordination, services and systems are deployed and operational.

2. WIRELESS NUMBER PORTABILITY

2.1 Solution Overview

Figure 2-1 displays a model of the building blocks for implementing WNP. An explanation of the model follows the figure.

Figure 2-1 Wireless Number Portability Building Blocks

```
┌─────────────────────────────────────────┐   ┐  Platforms impacted
│   Number Portability Administration      │   ├  include
│                                          │   │  NPAC-SMS
│   NPAC-SMS                    LSMS        │   ┘  & Local SMS
├─────────────────────────────────────────┤
│        Call Routing Algorithm            │
│                                          │
│               LRN                        │
├─────────────────────────────────────────┤
│        Separate MDN & MSID Values        │
│                                          │
│   Support Call Delivery in NP environment│
│                                          │      Network Elements
├─────────────────────────────────────────┤      impacted include
│        Querying Network Entity           │      SCP, STP, MSC, HLR,
│                                          │      MC
│ Originating    Terminating    N-1   Other│
├─────────────────────────────────────────┤
│        Query Trigger Mechanism           │
│                                          │
│   AIN        IN        WIN        Other   │
└─────────────────────────────────────────┘
```

The five building blocks as illustrated in the figure are defined as follows:

- *Number Portability Administration*: This component contains the NPAC-SMS and LSMS which disseminate information regarding ported subscribers.

- *Routing Algorithm*: This component identifies the routing method by which calls are routed to the subscriber's new service provider (either wireless or wireline). The method is LRN.

- *Separation of MDN and MSID*: This component reflects the separation of the MDN and MSID and its significance to wireless registration and call delivery.

- *Querying Network Entity:* This component defines the network entity capable of querying to the NP-SCP database to obtain routing information. This entity could be in the Originating Network, Terminating Network, N-1 Network (i.e., the next to last capable network) or some other entity (e.g., a message center, a service node platform).

- *Query Trigger Mechanism*: This component encompasses the software procedure(s) within the querying network entity that activates a trigger and issues the query for portable NPA-NXX ranges. Possible trigger and query message mechanisms are AIN, IN, WIN or some other mechanism (e.g., IS-41) understood between an MSC and NP-SCP.

The right side of the figure maps the major functional hardware platforms to the building blocks. These building blocks drive the following major impacts to today's wireless network architecture:

(a) Incorporate call routing based on an LRN.

(b) Move to separate MDN and MSID values.

- Make the MDN the portable number; keep the MSID as a non-portable number and controlled by the wireless service provider. This separation is essential in order to avoid 10 digit translation in mobile registration and, equally important, in support system processing (e.g., roaming tables).

- Allow the MSID to be either a MIN or an IMSI.

(c) Support Global Title Translations (GTT).

The three items listed above are discussed in more detail. Also, Sections 3 (network architecture) and Section 4 (operations and administration) expand on the various points in the figure in greater detail.

2.2   Location Routing Number Call Routing

The Location Routing Number (LRN) is a 10-digit NANP-formatted Network Routing Address assigned to a switch. Of these 10 digits, the first six are significant to the Public Switched Telephone Network (PSTN) for routing a call. For an existing switch, this code is an NPA-NXX code block the switch currently serves.

A Number Portability Service Control Point (NP-SCP) maps every ported number to its serving switch's LRN. A query capable network along the route would perform a query to the NP-SCP to obtain the LRN associated with the called party's 10-digit DN in order to correctly route the call based on NPA-NXX translation of the LRN. The network then sets up the subsequent leg of the call by sending an ISUP Initial Address Message (IAM) with the LRN.

The concept of the N-1 network performing the query to the NP-SCP is often associated with the LRN call routing method. If N denotes the network sequence number of the terminating network in the call path, the N-1 network would identify the NPA-NXX of the dialed number as a portable block and would query the NP-SCP to retrieve the LRN. The subject of when to query the NP-SCP as it applies to WSPs is discussed in more detail in Section 3.

The ISUP IAM provides for an indicator noting a query has been performed. Therefore, any subsequent network need not perform additional queries.

The summary, the LRN routing method is characterized by the following:

(a) It does not require a single unique network address for each ported number. The network address for ported number is associated with the ported-to switch address.

(b) Call routing remains consistent with current call routing schemes.

Figure 2-2 illustrates a typical LRN routing of a call to a ported subscriber.

Figure 2-2 Routing with a Location Routing Number
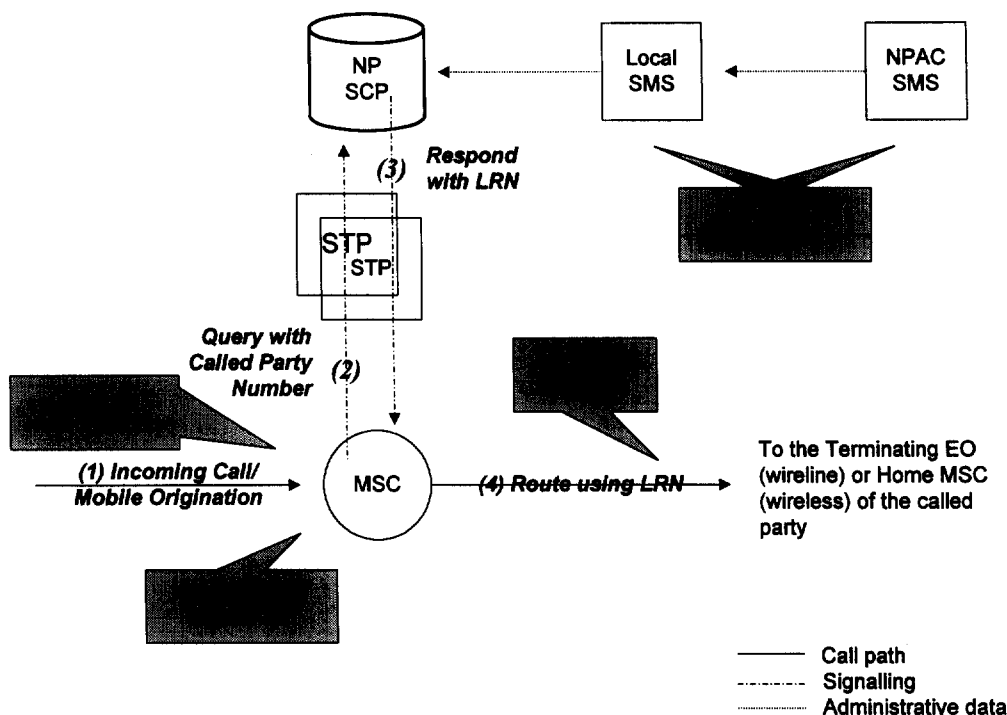
For completeness, the figure includes elements not directly involved in call processing, namely the NPAC-SMS and the LSMS.

2.3 Separation of the Mobile Directory Number from the Mobile Station Identifier

Prior to number portability, AMPS, CDMA and TDMA service providers performed registration, call processing, provisioning, customer care, and billing are based upon a single number for the subscriber - the Mobile Identification Number (MIN).

If today's MIN was portable, either a 10-digit Global Title Translation (GTT) or an NP-SCP dip would be required in order to locate the home network of the subscriber.[22] Neither of these alternatives is desirable. A dip during registration would increase the query rate on the NP-SCPs, and not all WSPs are equipped to perform 10-digit GTT in the time frame required.

In WNP, mobile stations will possess two types of numbers: a Mobile Station Identifier (MSID) and a Mobile Directory Number (MDN). The MDN will be a dialable NANP directory number, in the NANP format and will be the portable number. The MSID will be either an E.212 IMSI[23] and/or a NANP-like MIN and will not be portable.

With the introduction of number portability, existing TDMA and CDMA subscribers not yet ported will have two numbers (the MDN and the MSID) though both most likely equal to the existing MIN. When the subscriber ports, the MDN and MSID become separate and distinct. The ported subscriber will surrender the MSID to the donor network and receive a new MSID from the recipient network. The ported subscriber's MDN will remain unchanged. The donor network can then freely use this MSID for a new subscriber. It is possible that the same number may be used for an MDN in one network and an MSID (as a MIN) in another network. No adverse impacts because of this situation, however, have been identified

The GSM standards presently account for separate numbers: an E.212 IMSI for identifying the mobile station and an E.164number for dialing the mobile station.

Using an IMSI as the standard mobile station identifier was established as a goal of the wireless industry before the introduction of number portability. Because of this, the CDMA and TDMA standards allow for E.212 IMSIs in all mobile stations. Therefore, many CDMA and TDMA carriers may take advantage of the implementation of WNP to introduce IMSIs. However, the entire wireless industry may not flash cut to IMSI.

The industry must support MSIDs in IMSI and in MIN formats. This requires the following:

---

[22] Refer to CTIA RFI Open Forum submitted responses

[23] *International Mobile Station Identity (IMSI) Assignment Guidelines and Procedures*, Prepared by a Wireless Industry Forum, Sponsored by CTIA and PCIA, Version 1, February 12, 1996.

- IMSI-capable networks and IMSI-capable mobile stations must be capable of supporting both IMSI and MIN MSIDs in order to continue to roam on non-IMSI-capable networks.

- Administration of MINs as MSIDs must be addressed (outside the scope of this document).

Variations and implementations of IMSI are being addressed in other forums and are not in the scope of WNP as long as the first six digits of the identifier can be used to ascertain the home network.

2.4   Global Title Translation for Number Portability

In addition to currently defined uses, Signaling System 7 (SS7) GTT may be used to support routing for the WNP query and for other services impacted by number portability. A 6-digit GTT is recommended in the WNP environment for delivery of the LRN query to the NP-SCP. If a WSP does not have GTT capabilities, direct MTP routing to the NP-SCP to obtain the LRN may be used.

GTT may be used to route messages for various services to the appropriate network element (e.g., recipient switch) when an NPA-NXX of a dialed number no longer uniquely identified the targeted network element. To support SS7 inter-system message for such services as CLASS, LIDB, or CNAM, GTT must be available somewhere within the service provider's network (or extended network relying on another provider for portability).

3. THE WNP NETWORK REFERENCE MODEL AND PROCEDURES

This section discusses the necessary wireless architecture (Section 3.1) and the feature interactions (Section 3.3) necessary to support WNP. Section 3.2 illustrates the various call routing scenarios via information flow diagrams. Section 3.4 presents some performance considerations.

3.1 Network Configuration

Figure 3-1 illustrates the network entities involved in wireless number portability. Specifically, this reference model only depicts those entities which are impacted by number portability; other entities might exist in wireless networks but may not be directly impacted and therefore, are not included. Other features and services (e.g., Voice Mail) that are not implemented in a standard manner must be studied by each WSP independent of this effort.

Figure 3-1 WNP Network Reference Model
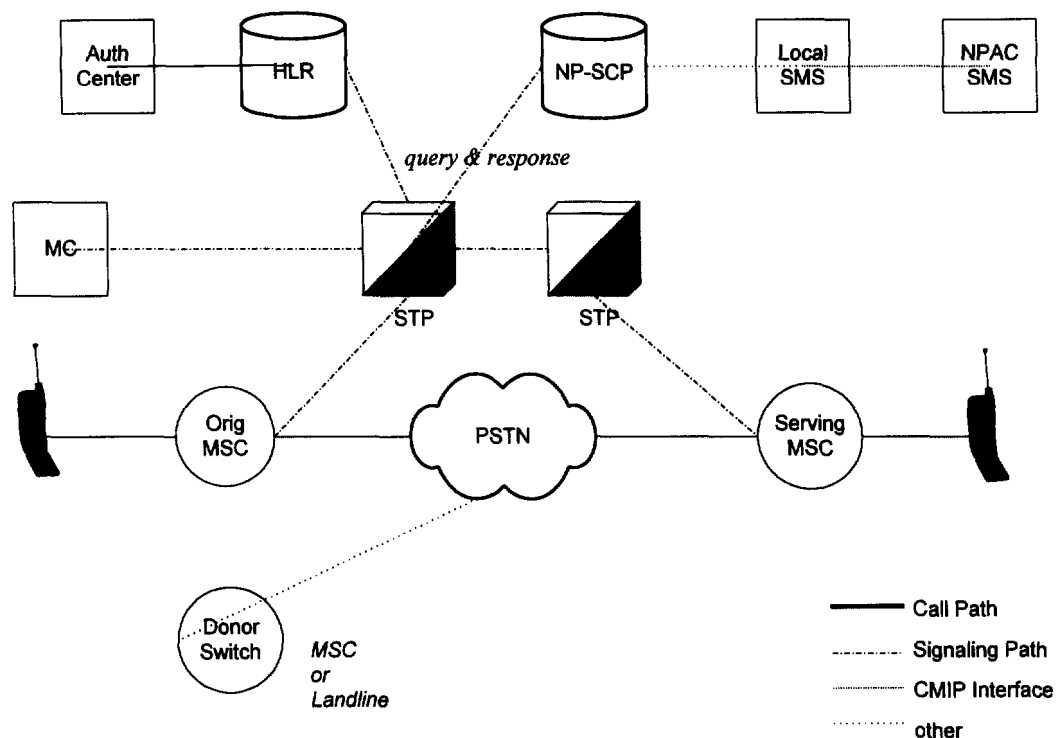
The sub-sections following this figure explain the details of the WNP solution, including a description of each of the elements and the signaling between each of the elements. Although

the NPAC-SMS and LSMS are included, Section 4 presents a detailed description of the service management and operating infrastructure.

3.1.1   *Number Portability Service Control Point*

The NP-SCP is the database accessed in real time by the switches to provide the LRN value for a ported subscriber in order to correctly route a call.   It contains the number portability information originally transmitted by the NPAC-SMS via the LSMS. Each service provider will either own or have access to an NP-SCP that will include the mapping of ported 10-digit DNs to their associated LRNs.

The WNP solution presumes, at present, the following data elements, at a minimum, must exist in each NP-SCP to support routing calls to ported numbers:

- Directory Number
- Location Routing Number

This document later suggests that MSID might be necessary for the support of Short Message Services (SMS) in number portability. Reference Section 3.3.5 for more details.

3.1.2   *Mobile Switching Centers*

An MSC is a wireless switch. Besides call routing, an MSC typically maintains the Visitor Location Register (VLR). In addition, depending upon the WSPs chosen architecture, the MSC might keep the Home Location Register (HLR). Some providers deploy remoted HLRs; others deploy HLRs integrated with the MSC.

The WNP Network Reference Model depicts three types of MSCs: Originating, Donor, and Serving. The Donor MSC is defined in Section 1.3. The Serving MSC is the MSC with which the subscriber is currently registered. Although not shown on the model, a Home MSC is the MSC which maintains the NPA-NXX relative to the subscriber's number. If the subscriber is registered "at home," the Home and Serving MSC are one in the same. If the subscriber is roaming, the Home MSC routes the call to the appropriate Serving MSC. Relating to WNP, routing by the LRN might take the call to the Home MSC. Routing from the Home MSC to the Serving MSC is a standard component of wireless architecture independent of number portability.

Routing within the subscriber's service provider network is at the discretion of each individual service provider. For example, a service provider may elect to deploy a single national or several regional 'gateway' MSCs. With the regional gateway architecture, all inbound calls to the service provider's subscribers would be routed by the PSTN to one of these 'gateway' switches. The service provider would then use internal logic to get the call routed to the appropriate subscriber. This type of architecture is supported by the WNP solution and should have no impact on the other service provider networks.

The MSC will need to have the capability to identify an NPA-NXX as being portable (i.e., contains ported numbers) in order to recognize the need for an NP query. An industry agreement is moving forward to add a portability flag to the Local Exchange Routing Guide (LERG).

Current roamer tables will continue to be valid for MINs but will no longer be valid for MDNs. Roamer tables should operate on MSIDs, whether MIN or IMSI.

The signaling for call connection to and from an MSC is discussed in Section 3.1.6, and the signaling for query from the MSC to the NP-SCP is discussed in Section 3.1.7.

3.1.3   Signaling Transfer Points

The STP provides SS7 signaling between the network elements per the reference model in Figure 3-1. The STP also provides the Signaling Connection Control Part (SCCP) signaling message translation and routing function. For number portability, the STP SCCP function determines the location of the NP-SCP and forwards the query. The query response message from the NP-SCP is returned via the STP.

3.1.4   Signaling

ISUP signaling is currently being enhanced to communicate NP query indicator and associated call routing information to the downstream networks.[24] The WNP solution is consistent with the wireline NP solution with regard to the necessary enhancements to the IAM message and therefore, with the Call Completion to a Ported Number (CCPN) enhancements. While this document specifies ISUP for number portability signaling, it recognizes networks which will use MF signaling or rely on third party networks. Both the ISUP and MF trunk signaling are discussed below.

3.1.4.1   ISUP signaling

The LRN approach requires additional signaling information for communicating the query status and routing information necessary for the establishment of call connections to a ported number. Call connections are made using the LRN of the home (recipient) MSC. The query indicator is needed to prevent subsequent switches in the call path from making unnecessary database dips. Finally, the serving switch also needs the dialed number for call termination. ISUP signaling ensures that the necessary additional signaling information will be available to the home MSC.

To explain in more detail, after the MSC queries the NP-SCP for a call initiation to a ported number and the MSC is ready to establish the call connection, an IAM is formulated with the enhancements documented in Table 3-1.

---

[24] CCPN SS7 network capability in *T1 LB 557 Signaling System Number 7-Number Portability Call Completion to a Portable Number - Integrated Text* currently in ballot to become an American National Standard

Table 3-1 ISUP IAM Parameter Settings

IAM Parameters [25]	Ported Not Dipped	Ported Dipped	Not Ported Dipped	Not Ported Not Dipped
Called Party Number (CdPN)	dialed DN	LRN	dialed DN	dialed DN
Generic Address Parameter (GAP)	n/a	dialed DN	n/a	n/a
Forward Call Indicator (*FCI*)	FALSE	TRUE	TRUE	FALSE

(Note: This table only includes those parameters affected by NP.)

If the calling party is a mobile station, the Calling Party Number (CgPN) must be populated with the MDN of the originating mobile station. If the subsequent switch does not support ISUP enhancements, then the GAP and FCI parameters are not applicable and should not be populated.

A subsequent switch upon detecting the FCI as set for "translated number" should not perform an NP query. If the FCI is not set, a subsequent switch may query the NP-SCP. Some wireless service providers may arrange for another network (via business agreements) to perform the NP query. In this case, the switch routes the call to the aiding network where the NP query is launched. After this switch performs the database dip, it formulates the IAM message with the dipped settings and routes the call as appropriate.

The home MSC recognizes that it serves the dialed ported number by knowing the LRN in the CdPN is its own LRN. Upon this recognition, it retrieves the dialed number from the GAP parameter. If the dialed number has not been ported but is within a portable number block, the MSC can determine that it is the home MSC by recognizing that the FCI is set and it serves the dialed DN in the CdPN parameters. The home MSC will use the dialed number to terminate the call.

When a donor switch receives an IAM with the FCI not set, it should perform the NP query and route the call to the appropriate switch. Such might the case if there has been some network failure.

Another IAM parameter being discussed in conjunction with wireline number portability (yet not included in the table above) is the Jurisdiction Information Parameter (JIP).[26] The JIP is an optional parameter in the ISUP standard. The WNP Solution is not advocating nor opposing the population of this parameter in the outgoing IAM at this time.

---

[25] CCPN SS7 network capability in *T1 LB 557 Signaling System Number 7-Number Portability Call Completion to a Portable Number - Integrated Text* currently in ballot to become an American National Standard

[26] *Generic Switching and Signaling Requirements for Number Portability*, Illinois Number Portability Workshop, Generic Requirements Issue 1.04, January 20, 1997.

3.1.4.2 ISUP Signaling with MF Signaling to the Home MSC

When ISUP signaling is available throughout the call path except at the final trunk MF signaling, the switch interworking ISUP and MF signaling will need additional capabilities. The interworking switch must locate the destination switch using the CdPN in the incoming IAM, and then extract the dialed ported number and use it as the called party address in signaling the destination switch. A destination switch must recognize that it is the home switch of the dialed ported number. It will terminate the call using the called party address.

3.1.4.3 ISUP and MF Signaling Interworking

Call paths that contain a mixture of ISUP and MF signaling are inefficient. After a switch obtains the LRN from the NP-SCP, for example, it formulates an IAM message. When the IAM arrives at an interworking switch that switch can only signal the dialed number to the next switch using MF signaling. The switch after the interworking switch may have to perform a redundant NP query to determine how to route the call. A mixture of ISUP and MF signaling in the call path will require multiple LNP queries to route the call to the serving switch.

3.1.5 WNP Trigger and Query Types

Triggers and queries are tightly coupled with intelligent network architectures for the deployment of advanced services. Such architectures include the following:

- Intelligent Network (IN)
- Advanced Intelligent Network (AIN)
- Wireless Intelligent Network (WIN)

Each of these intelligent network architecture utilities specific query protocols and procedures, terminology, and capability subsets. The WNP solution, however, recognizes that, prior to the implementation of any of these architecture, specialized trigger and query development may be required. This document recognizes that WSPs will have different implementation needs and that various standards bodies (e.g., T1P1, TR45.2) have a challenge to arriving at the standard trigger and query message (e.g., prior to WIN definition). These qualifiers will become more evident in the following subsections.

3.1.5.1 Trigger Type

Triggers expand basic call handling by allowing additional procedures to be defined and controlled by an external entity. The additional procedures are defined so that when certain conditions are met, the trigger is invoked. A common result of the trigger processing is initiating a specific TCAP query to an external element for information or instructions on how to proceed.

A trigger must be defined and implemented in the MSC in order to launch the query to the NP-SCP for number portability. However, the trigger is not dependent on the introduction of any

specific intelligent network architecture. Thus, the WNP solution does not specify requirements that any of the intelligent network architectures must be utilized or deployed, nor does it prohibit the use of any. WSPs can implement what is appropriate to their network.

This trigger involves the determination of which calls result in NP queries. It will be a conditional trigger based upon 3 to 10 digits of the dialed number and will be administered at the MSC. If defined in relation to other non-WNP triggers, the trigger for WNP should generally be the lowest priority of all of the dialed number triggers.

Services that involve persistent transactions[27] may be impacted with the implementation of WNP. A WNP trigger may be encountered in some persistent transactions. If the persistent transaction must be closed before an WNP query to the NP-SCP can be launched, these services may not function properly.

3.1.5.2 Query Type

The WNP query is a TCAP message sent to the NP-SCP as initiated by the WNP trigger discussed above. Upon satisfying all of the trigger conditions, the MSC sends the query with the 10-digit DN. If the number is ported, the NP-SCP responds with an LRN for that DN. If the number is not ported, the NP-SCP typically responds with the DN.

Various intelligent network architectures offer different query message types for communication between the switch and the database. Also, WSPs can choose to implement any of the protocols suitable to their networks and their chosen NP-SCP platform. WNP does not pose any requirements as to a specific query type.

The following is an overview of the options:

- *IN-based Protocol*: The switch initiates a "Instruction Start" message and awaits the "Control Connect" response. The IN based protocol is implemented in wireline portability and is anticipated to accommodate WNP without modifications.

- *AIN-based Protocol:* The switch initiates a "Info Analyzed" message and awaits the "Analyze Route" response. The query message indicates the CdPN as well as the Calling Party Number (CgPN) and bearer capability (e.g., the call type is voice). Though the latter two parameters are not required for portability, they are mandatory in the "Info Analyzed" message.

- *WIN-based Protocol:* A WIN-based protocol could be defined for querying the NP-SCP. It would include the DN and would be capable of returning the LRN, at a minimum. WIN, however, is an intelligent architecture currently being defined. The

---

[27] A persistent transaction is an intelligent network process that is maintained after the initial message exchange. An example might be the Auto Redial service which can be invoked after encountering a busy signal to monitor the busy line and receive a call back when the line is available.

WNP query will be required in advance of WIN incorporation in standards. Therefore, the WNP query may or may not be WIN-based.

- *Other*: A message could be defined outside of the other three call models; for example, an IS-41 message might be defined. Also, a GSM message must be defined, and it may or may not fall within any of the above call models.

3.1.5.3 Automatic Code Gap

The MSCs are not typically equipped with Automatic Code Gap[28] (ACG) capabilities as they do not normally trigger an SCP (in today's wireless environment). However, NP-SCPs are required to support mechanisms to control overload situations via ACG. ACG Indicators parameter of TCAP indicates the cause for applying an ACG control, the time duration for the ACG control to be in effect and the time interval (gap) between ACG application Consequently, MSCs should recognize and react appropriately to such indications in the TCAP message from the NP-SCP.

As ACG is mainly being suggested so that a WSPs can query an SCP also serving a wireline provider and deployed in a wireline environment, the WNP Solution suggests that the ACG implemented for the wireless query be in line with the wireline ACG standards and requirements for Number Portability.

3.1.6 Trigger Conditions

The trigger should activate if the NPA-NXX of the CdPN matches an NPA-NXX open for portability within the region served by the MSC (as provisioned in the MSC NP routing tables). [29] A WSP might also, however, provision the MSC to activate the trigger based upon other conditions (e.g., interconnection agreements). An MSC need not perform a query if the Called Party Number is served by the MSC itself.

3.1.7 Global Title Translation

GTTs are used in the WNP environment, based on the DN, the MIN, and the IMSI. The following text describes some of the GTTs available. The need for new translation type assignments will be identified as part of the NP standards process. This section defines and categorizes the possible GTT uses in the WNP environment. It is not a specific request for new translation type assignments.

---

[28] ACG is sometimes referred to as Automatic Call Gapping, however the TCAP standards terminology for the control is Automatic Code Gap.

[29] This condition rules out querying on operator services calls and N11 (e.g., 911 calls) as is appropriate.

3.1.7.1 Number Portability Global Title Translation

NP GTTs are 6-digit GTTs used to direct WNP query messages to the NP-SCP to obtain the LRN routing information. The SCCP Called Party Address (CdPA) of NP GTTs contains the first six digits of the dialed DN. The wireline industry is pursuing the idea of a separate TT value for each protocol versus one TT value for all three (i.e., AIN, IN, and WIN). Separate TT values would allow the GTT function to provide a separate subsystem number (SSN) for each protocol. If just one TT value is used for all protocols, the NP-SCP must then determine the type of protocol as part of TCAP processing.

3.1.7.2 Mobile Station Identifier Global Title Translations

MSID GTT messages, if identified, contain the MSID in SCCP CdPA. They are used to perform GTT for MSID-based inter-network capabilities and services. Four GTTs are needed for MSID:

- six digits of the MIN to locate the HLR
- six digits of the MIN to locate the Message Center
- six digits of the IMSI to locate the HLR
- six digits of the IMSI to locate the Message Center

3.1.7.3 Mobile Directory Number Global Title Translations

Most GTTs in the past have been based on the MIN. However, with the separation of the MSID and MDN, GTT based on MDN may be needed to achieve this past functionality. MDN GTT messages, if needed, contain the MDN in the CdPA. They are used to perform GTT for MDN-based network capabilities and services. There are significant GTT impacts for MDN based activities that only provide the first six digits of the MDN in the CdPA. The impacts are because the previously used six digit numbering schemes no longer provide sufficient addressing granularity in a number portability environment. When a customer ports to a new service provider, a 10-digit GTT entry is needed in each inter-network service GTT database so that queries are delivered to the appropriate network. In these cases, inter-network service GTT databases will have 10-digit GTT entries and 6-digit default entries. The 10-digit GTT entries of the GTT database are the numbers ported to a new service provider in the served portability area that require inter-network service. When a 10-digit GTT entry for a ported subscriber is not found, the 6-digit default GTT is interrogated to obtain the necessary routing information.

Two solutions are available to address service GTTs. The first modifies all query originating applications to provide ten digits in the CdPA for GTT. This solution is not preferred by the wireline industry due to the update expense of the originating offices. The second solution, called TCAP-GTT, is used when only six digits are available in the CdPA. TCAP-GTT performs GTT by obtaining the MDN (or dialed digits) from the TCAP portion of the message. Note that this case requires a ten-digit MDN (or dialed digits) in the TCAP portion of the message. In most cases, this information is available. Normal SCCP error procedures should be invoked if the GTT fails, even if the failure occurred during TCAP interrogation.

3.1.7.4 Wireline Service Global Title Translations

Wireline Service GTTs for services sent to or received from wireline networks may be needed in wireless networks. These GTTs require 10-digit translation in order to determine the appropriate destination where the query is to be sent. Impacts to these GTT database are the same as described in Section 3.1.7.3 above.

3.1.8 Home Location Register and Authentication Center

The Home Location Register (HLR) is a standard function of wireless signaling and mobility management. The WNP solution presumes the HLR to serve the same function. The HLR holds the subscriber profile which should be capable of separating and mapping the MDN to the MSID.

The Authentication Center is also a standard function in wireless telecommunications. The separation of the MSID and the MDN may impact the AC and its associated authentication formulas; the signaling between the HLR and the AC, however, is not likely to be impacted by WNP

3.1.8.1 Directory Number to HLR Mapping

When a Location Request message is routed to the home network, the network must route the Location Request message to the subscriber's HLR. Some networks have stand-alone HLRs separate from the MSC; some networks have multiple HLRs.

HLR subscriber profiles are typically arranged and indexed by MSID. However, the home network may only have the subscriber's MDN to use for routing the Location Request message to the HLR serving the subscriber. Service providers that employ stand-alone HLRs or have multiple HLRs supported an MSC need to ensure that the Location Request message is routed to the correct HLR for the subscriber. This scenario is further complicated if a WSP deploys an MSC gateway architecture.

Service providers can implement a Location Request routing method that is effective in their internal network.

3.1.9 Abnormal Procedures

A number of situations exists where a call requires WNP processing but a failure prevents the switch from receiving an LRN for routing the call. Such instances include

- signaling link failure,
- NP-SCP outage or overload,
- WNP query timer expire, or

- incorrect STP translation.

Regardless of the cause, the MSC should route the call as if the dialed directory number were not in an open portable block. Specifically, the FCI bit in the IAM message should not be set and the CdPN parameter should contain the dialed DN.

This procedure of routing the call as if it were not ported is called "default routing" and ensures that additional attempts will be made to complete the call. With default routing, a chance exists that the call might route to the donor network. The donor network should attempt to perform the query and re-route the call to the correct service provider.

3.2   Call Flows

The call flows in this section are included to illustrate the inter-workings of the above network architecture. They are based on IS-41 but are not meant to preclude GSM based protocols. The messages are meant to convey the required function and are not necessarily the actual messages defined in the protocol. Furthermore, the call flows do not represent all the information that is conveyed in each instance, only that pertinent to number portability. The call flows are based on normal procedures and do not include error conditions.

3.2.1   Registration and Authentication

Because of the separation of the MDN and the MSID, the process of registration and authentication remains unchanged in WNP. Therefore, no call flow for registration and authentication has been included.

The information exchange, however, is impacted. When the mobile registers, it will pass the MSID Upon receiving an MSID in the registration notification message, the HLR shall include the MDN of the mobile subscriber in the registration notification response message. This will provide the MDN to the Serving MSC/VLR for subsequent call processing.
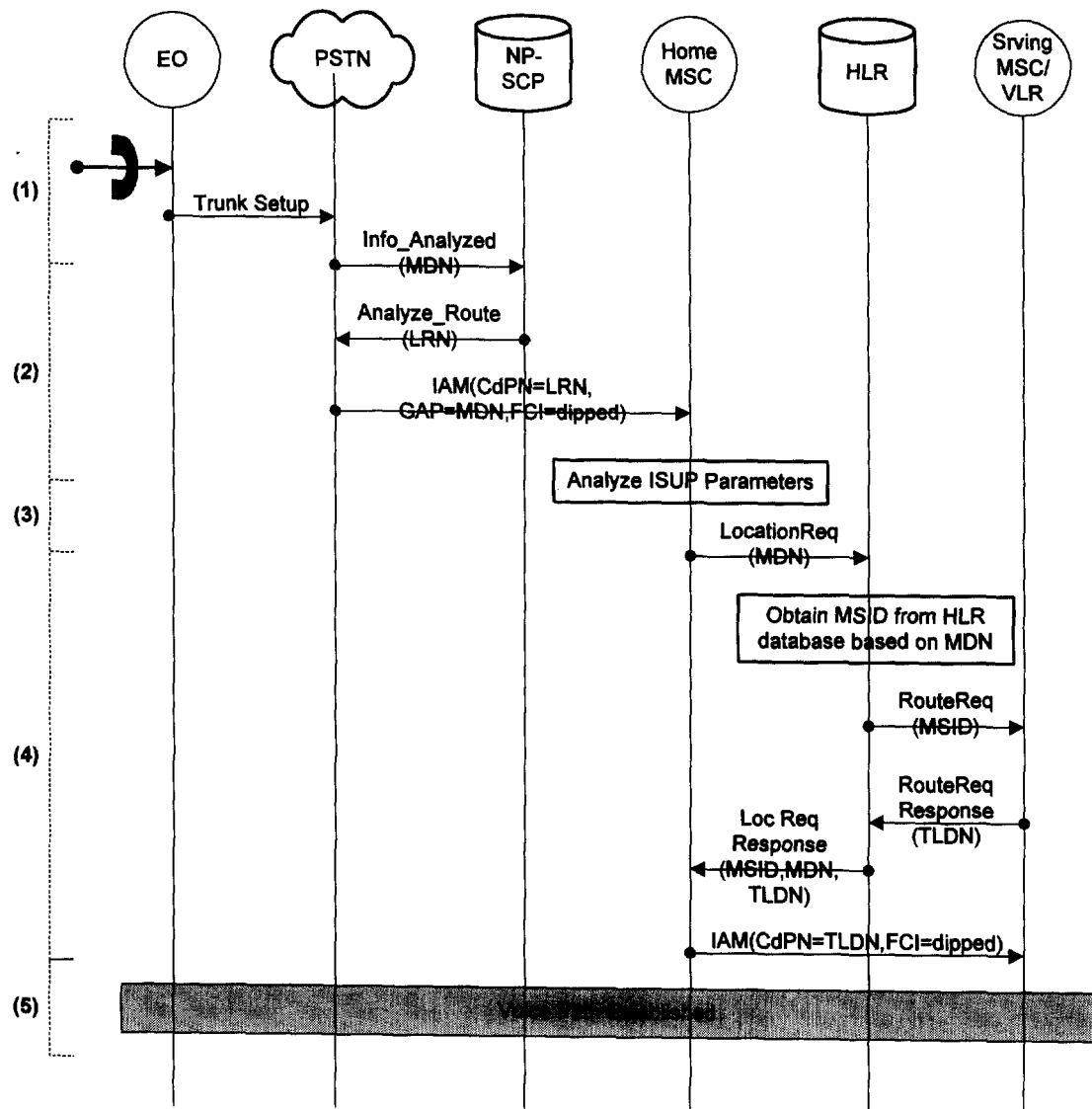
3.2.2   Call Routing To a Ported Directory Number

Wireless call routing can be divided into three scenarios: Land-to-Mobile, Mobile-to-Land, and Mobile-to-Mobile.

3.2.2.1   The Landline-to-Mobile Call

Figure 3-2 illustrates a landline call to a ported mobile subscriber. Text follows the figure for an explanation of each step.